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Superconducting studies on Ho($Ba_{2-y}La_y$)Cu_3O_z ($0 \leq y \leq 0.5$) system

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The ionic size of the light rare earths is comparable to that of barium and hence it gives a wide scope for substitutional studies resulting in single phase compounds of the type R($Ba_{2-y}R'_y$)Cu_3O_z (R=rare earth, R′=light rare earth). We have investigated the structural and superconducting properties of single-phase La-substituted compounds of the formula Ho($Ba_{2-y}La_y$)Cu_3O_z ($0 \leq y \leq 0.5$) through neutron diffraction, resistivitiy and magnetization studies. The compound $HoBa_2Cu_3O_z$ is orthorhombic and exhibits superconductivity with transition temperature T_c of $\sim$ 90 K. From the analysis of the neutron diffraction data on this compound, the oxygen occupancy at O(1)[0,$\frac{1}{2}$,0] and O(5)[$\frac{1}{2}$,0,0] sites is found to be 0.843, 0.115, respectively, with total oxygen content, z, of 6.96 per formula unit. It is observed that, on increasing La in Ho($Ba_{2-y}La_y$)Cu_3O_z, the O(1) occupancy decreases and the O(5) occupancy increases resulting in a decrease in orthorhombicity. The oxygen content per formula unit, z, increases to $>$7 and the cell volume decreases as more divalent Ba is replaced by trivalent La. The superconducting transition temperatue, obtained from d.c. four-probe resistivity and magnetization measurements, decreases from 90 K for y=0.0 to 26 K for y=0.5. This suppression in T_c is attributed to hole filling/localization by La.